“Training for On-site Measurements for Performance Evaluation of Middle- and Large Scale Biogas Plants in China for Biogas Laboratories”

中国大中型沼气工程运行评估

现场监测培训

in Beijing, May 2010

2010 年 5 月　北京

PD Dr. Joachim Clemens
Dipl.-Ing. agr. Carsten Hafermann

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1 Safety 安全

At a biogas plant, biogas is produced. Biogas consists of CO_2, CH_4, H_2S and some other trace gases.

沼气厂内，沼气不断产生，其是由 CO_2, CH_4, H_2S 和一些微量气体组成的。

When you are at a biogas plant, you HAVE to stick to some safety rules:

当在沼气厂工作时，请严格遵守安全规定：

1.1 Explosion 防爆

There is a risk of explosion close by the biogas plant and tanks. Don´t use open fire there and don´t smoke!

在沼气厂以及其内罐体周围存在爆炸危险，所起请不要使用明火及禁止吸烟！

1.2 H_2S Toxicity H_2S 中毒

Be careful when you open closed tanks! It may happen, that H_2S emits. At high concentrations, this is toxic and may kill you.

请小心打开关闭的罐体，其有可能放出 H_2S。在浓度高时 H_2S 是有毒的，并可致死。

There were several dead persons because of H_2S toxicity in Germany.

在德国曾发生或 H_2S 中毒致死事件。

1.3 CO_2 – Suffocation CO_2 窒息

Don´t enter fermenters when they are “almost empty”. CO_2 is a gas that is heavier as compared to air. This means, CO_2 may be in the fermenter and when you go into the fermenter, you may suffocate.

当发酵罐“近空”时不要进入。CO_2 比空气重，这意味着当你进入时仍有 CO_2 残留，这会造成窒息。

Every year farmers die because they enter their slurry tanks in Germany!

在德国，每年都会发生由于进入发酵罐而发生的窒息致死事件。

SUMMARY 总结

- Don´t use open fire and smoke

  不要使用明火及吸烟
- Be careful when you open a tank
  小心打开罐体
- Don´t enter a fermenter or a tank
  不要进入任何罐体

2 Sampling 取样

The biggest errors occur during sampling. Even when your laboratory analysis is correct, this does not help, if the sampling was not careful.

在取样时常常发生重大错误。如果取样不小心，即使实验室分析正确，也是没有用的。

In principle, you need to mix the sample before you take it.

原则上，在取样前需要混合样品。

2.1 Input Substrates 进料

Solid samples: Take from a big sample (e.g. a small truck) from different places minimum 10 subsamples of around 0.5 – 1 kg. Mix the subsamples and take then the sample for analysis.

固体样品：从大的样品中（例如小卡车内）于不同部位提取至少 10 份 0.5 – 1 公斤的样品，混合后作为待分析样品。

Liquid sample: Mix the substrate if possible. Then take different subsamples of around 0.5-1L. Mix the subsamples and take then a sample for analysis.

液体样品：如果可能的话混合发酵原料，然后提取 10 份 0.5 – 1 公斤的不同样品，混合后作为待分析样品。

2.2 Output Material 出料

Usually, the output material is liquid and flows out of the fermenter as soon substrate is pumped into the fermenter. This may take minutes or sometimes around one hour. Please take a representative sample.

通常，出料是液体的，流出的发酵原料很快被泵入发酵罐。这有可能花费几分钟或一小时，请提取有代表性的样品。

This means:这意味着：

- Check how long is material pumped out of the fermenter (e.g. 20 minutes)
  确定原料泵出发酵罐的时间（例如：20 分钟）
- Then divide this time by 10. (in this case: 2 minutes)
  用这个时间除以 10。（依上例：2 分钟）
- Then take every 2 minutes a sample of around 1 L.

每两分钟提取一次样品，大概 1 升。

- At the end you have a 10 L sample. Mix it and take one sample of 1 L
  最后，将得到 10 升样品，混合后保留一升作为待测样品。

2.3 Flow 流量

Material is pumped into the fermenter by pumps. Your task is to determine the pump rate of the pump and the time of pumping.

发酵原料被泵入发酵罐。监测人员的任务是测定泵的效率和运行时间。

For this purpose, you have to work together with the operators. They should pump into a basin where you can analyse the amount of substrate pumped per minute.

为了达到上述目的，监测人员需要和沼气厂操作工人一起工作。他们应该将原料泵入一个盆内，以利于分析每分钟的原料流量。

Then you can record the time of pumping every day.

然后，监测人员可以记录每天泵的运行时间。

3 Dry Matter/Water content 干物质/含水量

3.1 Tools/Materials 设备/材料

- Drying oven 烘箱
- Balance 称（天平）
- Aluminium Bowl or glass 铝坩埚或玻璃烧杯

3.2 Procedure 步骤

1) Weigh the aluminium bowl/glass and note the weight (w_1)
2) Weigh around. 500 g material into aluminium bowl/glass and note the weight (w_2)
3) Put the sample into a drying oven at 105° - 120° C until the material does not loose water any more (around 24 hours later).
4) Weigh the sample again (w_3)

1）称量铝坩埚/玻璃烧杯，并记录重量（W1）。
2）称量大约 500 克发酵原料，放入铝坩埚/玻璃烧杯内，称量并记录重量（W2）。
3）将样品放入 105° - 120° C 烘箱内，直到重量不再降低（大约 24 小时）。
4）再次称量样品（W3）。

3.3 Results 结果

Gravimetric water content 含水量

Calculate Dry matter content: 计算干物质含量：

DM (% of fresh mass) = $((w_3 - w_1)/(w_2-w_1))/100$

4 Organic Dry Matter (oDM) 有机干物质含量

Please note: this parameter is hard to determine onsite as you need a muffle furnace.

请注意：该项参数无法在现场测定，因为需要马弗炉。

4.1 Tools/Materials 设备/材料

- Muffle furnace 马弗炉
- Ashing crucible of porcelain 瓷坩埚
- Exsiccator 干燥器
- Balance (with readings of 1 mg) 天平(刻度 1 毫克)

4.2 Procedure 步骤

1) Anneal the ashing crucibles at 500°C, cool them down in an exsiccator and weigh them.
2) Put 2-3 g of the dry (and perhaps milled) sample in the crucible.
3) Put the crucible into the muffle furnace for 5 hours.
4) Cool the crucible down in an exsiccator and weigh them.

1）将瓷坩埚放入 500°C 马弗炉内，在干燥器内冷却并称重。
2）放入 2-3 g（可能是粉末）样品于瓷坩埚内。
3）放入马弗炉加热 5 小时。
4）在干燥器内冷却并称重。

4.3 Results 结果

Calculate the content of organic substance.计算

$oDM = (weight_{\text{crucible + substrate before annealing}} - weight_{\text{crucible + substrate after annealing}}) / weight_{\text{substrate before annealing}}$

$oDM = (weight_{\text{坩埚+干燥前原料}} - weight_{\text{坩埚+干燥后原料}}) / weight_{\text{干燥前原料}}$

5 Electric Conductivity 电导率

5.1 Tools/Materials 设备/材料

- EC-meter 电导率测定仪
- Glass 玻璃烧杯
- Sieve 筛子

5.2 Procedure 步骤

1) Follow the description for maintenance for the EC meter.
2) Measure EC in the sample directly.

1）按照说明书调节电导率测定仪。
2）直接测定样品电导率。

6 PH-Value pH 值

6.1 Tools/Materials 设备/材料

- pH-meter pH 计
- calibration solution 校准液
- Sieve 筛子

6.2 Procedure 步骤

1) Follow the description for maintenance for the pH meter (calibration and KCl).
2) Measure pH in the sample directly.

1）根据说明书调节 pH 计（校准液和氯化钾溶液）。
2）直接测定样品 pH。

7 Titration to determine Alkalinity and Volatile Fatty Acids 滴定法测定碱度和挥发性脂肪酸

7.1 Tools/Materials 设备/材料

- Buret 滴定管
- Buret holder 铁架台
- Glass (around 200 – 500 ml) 玻璃烧杯（大约 200 – 500 毫升）
- Spoon 勺子
- Balance 天平
- 0.05 M $H_2SO_4$0.05M 硫酸
- pH-meter pH 计

7.2 Procedure 步骤

1) Use 50 g digestate (this corresponds to V = 50 ml)
2) Analyse pH
3) Titrate with the H_2SO_4 to a pH of 5
4) Note the ml used (M_{TIC} [ml])

Calculate the TIC: TIC= (20ml/V[ml])*M_{TIC}*250
V[ml]= in the case that a sample volume differs from 20 ml (in your case 50 ml)

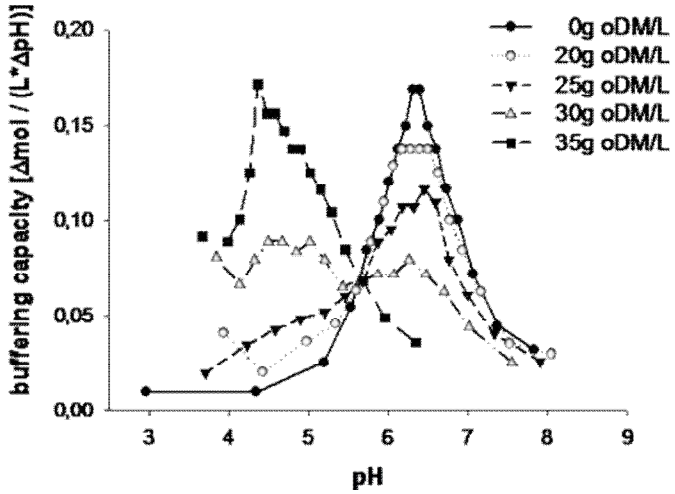
5)
6) Then titrate down to a pH of 4.4
7) Note the ml used (M_{FOS} [ml])

Calculate the VFA
VFA =((20ml/V[ml])*M_{FOS}*1,66-0,15)*500
V[ml]= in the case that a sample volume differs from 20 ml (in your case 50 ml)

8)

1）使用 50 克发酵剩余物 （体积相当于 50 毫升）。
2）分析 pH 值。
3）用硫酸滴定至 pH 为 5。
4）记录使用的毫升数(M_{TIC} [ml])。
计算 TIC：TIC=(20ml/V[ml])*M_{TIC}*250
V[ml] = 样品体积不是 20 毫升（试验中是 50 毫升）
5）再次滴定至 pH 4.4。
6）记录使用的毫升数。(M_{FOS} [ml])
Calculate the VFA
VFA =((20ml/V[ml])*M_{FOS}*1,66-0,15)*500
7）V[ml] = 样品体积不是 20 毫升（试验中是 50 毫升）

Information 信息



- The hydrogencarbonate buffer (pK_s = 6.5) decreases with rising digester loading, while the amount of organic acids ($pK_{a\ [acetate]}$ = 4.7) increases.

碳酸氢盐缓冲液（pKs=6.5）随着消化负荷的增加而降低。与此同时有机酸含量（pKa[乙酸]）增加。

8 Determination of Alkalinity with BiogasPro

用 BiogasPro 测定碱度

BiogasPro was developed to have a simple and fast method for the daily process control of your biogas plant.

BiogasPro 是一种简单而快速的沼气厂日常控制方法。

BiogasPro analyses the Hydrogen Carbonate buffer in your fermenter. This buffer is responsible for the safe operation as it buffers the organic acids that are produced during the degradation of organic material to biogas. And it keeps to pH in an optimal range for the methanogenic bacteria. In principle: the higher your buffer, the more stable your fermenter. However each fermenter is in a steady state. This means every fermenter has a specific optimal buffer capacity.

BiogasPro 分析发酵罐内的碳酸氢盐缓冲液。该缓冲液用于缓冲由于有机物降解生成甲烷而产生的有机酸，可以保障运行，并保证甲烷微生物处于合适的 pH 范围内。原则上，缓冲能力越高，发酵罐也越稳定。然而，每个处于稳定阶段的发酵罐，意味着每个发酵罐都有一个具体的最佳的缓冲能力。

During the analysis with BiogasPro, you transfer the Hydrogen Carbonate buffer into a gas using a reactant. The gas pushes water aside that is in the base of BiogasPro into a scaled cylinder (see picture below). The amount of the gaseous buffer can be determined easily by the scale on the cylinder.

在使用 BiogasPro 分析过程中，通过反应将碳酸氢盐气化，气体将处于 BiogasPro 基座内的水排入又刻度的量筒内（见下图），气化的缓冲液的数量可以很容易的通过刻度读出。

Again, there is no overall threshold for biogas plants. Every biogas plant is unique and has a critical buffer value. Below this value, acidification may occur and may stop the biogas process.每个沼气厂都是独一无二的，有自己的临界缓冲值。低于此值，可能会出现酸化现象，可停止沼气的产生。

Once, the buffer is below the specific critical value, you should react with a reduced feeding strategy. Additionally, we recommend analyzing the fermenter on volatile fatty acids as single parameters and/or contacting an advisor. Please contact us, if you want us to find an advisor for you.

一但缓冲能力低于具体临界值，你应该采取降低进料量，另外，我们建议分析发酵罐的挥发性脂肪酸，同时或者联系你的沼气顾问。如果你想找这样一个顾问，请联系我们。

How to use 如何使用

BiogasPro

Components 组件

1 Reaction vessel (big bottle) 反应器（大瓶）

2 Reactant vessel (small bottle) 反应器（小瓶）

3 Base (filled with water) 基座（装满水）

4 Cylinder (scaled and with zero mark) 量筒（零标记及刻度）

5 Beaker 烧杯

6 Protective cover 保护罩

Important, please use 重要的是，请使用

Protection goggles (enclosed) 护目镜（附后）

Protection gloves (enclosed) 防护手套（附后）

Safety Instruction: 安全说明:

Replace broken protection goggles and gloves immediately!
Reactant contains acid; avoid contact with skin and eyes!
Read safety instructions!

立即更换破损的护目镜和防护手套！
反应物含有酸，避免接触皮肤和眼睛！
阅读安全说明！

8.1 Preparation 准备

Fill into the base (3) of **BiogasPro** water until it stops ca 5 mm below the mark „0“ on the scale of the cylinder (4). Remove air bubbles inside the base by shaking the whole device. Air can be removed easier, if you remove the plug of the reactant vessel (2). Once air is removed, you may need some additional water.

在 BiogasPro 的基座（3）内注水，直到低于量筒上（4）的“ 0 ”标记 5 毫米处停止。摇动整体装置排除气泡。如果将反应器（2）上的塞子去除，空气更容易被去除。一旦空气被去除，您可能需要补一些水。

8.2 Sampling 取样

IMPORTANT! To determine the buffer capacity of the fermenter substrate accurately, you need a homogeneous sample. Please use only fresh material that was sampled immediately before the analysis. The **BiogasPro**-analysis should be done immediately after sampling. To get best results, we recommend analyzing the buffer capacity daily at the same time of the day.

重要！要准确测定发酵罐发酵底物的缓冲能力，你需要一个均匀的样品。请使用分析前刚刚区的新鲜原料。取样后应立即完成 BiogasPro 的分析。要获得最佳效果，我们建议每日同一时间分析缓冲能力。

8.3 Analysis 分析

1. Use the beaker (5) to add **200ml** substrate into the reaction vessel (1). For flushing, fill the beaker (5) with water and pour it into the reaction vessel, too.

   通过烧杯（5）向反应器（1）内加入 200 毫升底物。冲洗，向烧杯（5）内加入水，并倒入反应器。

   Please avoid material on the top of the bottle. Otherwise the lid may not close gas tight.

   避免材料达到瓶子顶部，否则盖子可能无法关紧。

2. CAREFUL, ACID: Now, please wear the protection goggles and gloves. Fill the reactant into the reactant vessel (2) up to the mark. Close the reactant vessel with the lid.

   小心，酸：现在，请戴上护目镜和手套。将反应物加至反应器（2）的标记处。关闭盖子。

3. Lift the reactant vessel above the reaction vessel. Now the reactant flows into the reaction vessel (fig. 1).

   将反应器提至反应器正上方。反应物流至反应器内（图 1）。

4. **Shake** the reaction vessel in circles for about 10 seconds (fig. 2). Please avoid that the two lids get loose during shaking. Now wait around 30 seconds.

   旋转摇动反应器大约 10 秒钟，（图 2）。请避免在摇动过程中盖子松动。现在，等待大约 30 秒。

5. Continue with the process of shaking/waiting until you can read a stable value on the cylinder.

   继续摇动/等待过程，直到你可以在

figure 1 figure 2

量筒上读到一个稳定的数值。

6. The buffer capacity can be read now using the scale on the cylinder. And you can compare the value with thresholds.

   读量筒上的数值即可以得到缓冲能力。您可以与临界值比较。

8.4 Emptying and Cleaning 清空和清洁

WEAR PROTECTION GOGGLES AND GLOVES! After the analysis, please open the lids to release the slight pressure. Rinse the vessel, the base and tubes with water. There is no need to remove the water from the base. Before you start with the next analysis, please check the water level in the base.

戴上护目镜和手套！分析完成后，请打开盖子释放一些压力。冲洗反应器，基座和管道。但没有必要将基座内的水去除。在您开始进行下一个分析前，请检查水位。

9 Analysis of NH_4-N with BiogasPro / BiogasPro 分析氨氮

9.1 Chemistry 化学方程式

Ammonium-N and Amino sugars are oxidized to N_2. 氨氮和氨基糖被氧化成氮气。

$$3\ NaClO + 2\ NH_4^+ + 2\ OH^- \Longrightarrow 3\ NaCl + N_2 + 5\ H_2O$$

With BiogasPro you can determine the Ammonium concentration in your substrate.

用 BiogasPro 可以测定基质的氨浓度。

9.2 Preparation 准备

Fill into the base (3) of **BiogasPro** water until it stops ca 5 mm below the mark „0“ on the scale of the cylinder (4). Remove air bubbles inside the base by shaking the whole device. Air can be removed easier, if you remove the plug of the reactant vessel (2). Once air is removed, you may need some additional water.

在 BiogasPro 的基座（3）内注水，直到低于量筒上（4）的“ 0 ”标记 5 毫米处停止。摇动整体装置排除气泡。如果将反应器（2）上的塞子去除，空气更容易被去除。一旦空气被去除，您可能需要补一些水。

9.3 Sampling

IMPORTANT! To determine the ammonium concentration of the fermenter substrate accurately, you need a homogeneous sample. Please use only fresh material that was sampled immediately before the analysis. The **BiogasPro**-analysis should be done immediately after sampling. To get best results, we recommend analyzing the ammonium concentration every two weeks.

重要！要准确测定发酵罐发酵底物的氨浓度，你需要一个均匀的样品。请使用分析前刚刚区的新鲜原料。取样后应立即完成 BiogasPro 的分析。为获得最佳效果，我们建议每两周分析一次氨浓度。

9.4 Analysis 分析

1. Use the beaker (5) to add **100ml** substrate into the reaction vessel (1). For flushing, fill the beaker (5) with water and pour it into the reaction vessel, too.

   通过烧杯（5）向反应器（1）内加入 100 毫升底物。冲洗，向烧杯（5）内加入水，并倒入反应器。

2. Please avoid material on the top of the bottle. Otherwise the lid may not close gas tight.

避免材料达到瓶子顶部，否则盖子可能无法关紧。

3. CAREFUL ACID: Now, please wear the protection goggles and gloves. Fill the reactant **Rimu*N-Fix*** into the reactant vessel (2) up to the mark. Close the reactant vessel with the lid.

   小心，酸：现在，请戴上护目镜和手套。将反应物 **Rimu*N-Fix*** 加至反应器（2）的标记处。关闭盖子。

4. Lift the reactant vessel above the reaction vessel. Now the reactant flows into the reaction vessel (fig. 1).

   将反应器提至反应器正上方。反应物流至反应器内（图 1）。

5. After approximately 5 minutes **shake** the reaction vessel in circles for about 10 seconds (fig. 2).大约 5 分钟后，旋转摇动反应器大约 10 秒钟，（图 2）。

6. Wait another two minutes. Then, the Ammonium concentration can be read now using the scale on the cylinder Continue with the process of shaking/waiting until you can read a stable value on the cylinder.

   等待 2 分钟，可以通过量筒上的刻度读出氨浓度。继续摇动/等待过程，直到你可以在量筒上读到一个稳定的数值。

   读量筒上的数值即可以得到氨浓度。

9.5 Emptying and Cleaning 清空和清洁

WEAR PROTECTION GOGGLES AND GLOVES! After the analysis, please open the lids to release the slight pressure. Rinse the vessel, the base and tubes with water. There is no need to remove the water from the base. Before you start with the next analysis, please check the water level in the base.

戴上护目镜和手套！分析完成后，请打开盖子释放一些压力。冲洗反应器，基座和管道。但没有必要将基座内的水去除。在您开始进行下一个分析前，请检查水位。

10 Your Tasks at the Biogas Plant 沼气厂工作任务

The overall goal is to determine the mass balance of a biogas plant. This means, you need to determine the input and the output in terms of kg/day.

总的目标是监测沼气厂的物料平衡。这意味着你需要每天监测进出料的公斤数。

Input materials can be: 进料可以是：

- Slurry, manure 污泥，粪便
- Water 水
- Food waste 食品废弃物

Output material is: 出料是

- Digestate 发酵剩余物
- Biogas 沼气

10.1 Materials 材料

It is important to know the substrates that enter the fermenter every day in terms of kg/oDM (organic dry matter).

重要的是指导每天进料的有机干物质量。

On the plant is hard to determine. This is why you need to estimate the amount of fresh substrate per day (kg/day).

在工厂很难检测，这就是为什么我们每天需要估计新鲜原材料的数量(kg/day)。

In a lot of cases you don´t have a big balance. In this case you have to determine the volume and density of the substrates. Example: Every day 10 big buckets filled with pig manure are fed into the fermenter. You can determine the volume of the bucket by measuring length, width and height. Let´s assume this is 100 Liter per bucket. Then you take a sample and analyze the density of the substrate. Let´s assume that 1 L of pig manure has a weight of 0.9 kg.

在大部分情况下，你没有一个大的称。所以你需要监测原料的体积与密度。例如，每天有 10 大桶原料进入发酵罐。你可以通过长宽高计算桶的体积。假设每桶 100 升，然后你取样品分析密度，假设密度为 0.9 kg/L。

Then the daily input of pig manure is:10 buckets/d * 100 L * 0.9 kg/L = 900 kg/d

则每天进料量为：10 桶/天 * 100 L * 0.9 kg/L = 900 kg/d

The next step is to determine the dry weight of the substrate: You can dry a sample in the oven. After drying and determining the dry matter content fill the dried material into a bottle or a plastic bag and bring it to the laboratory to analyze oDM later.

下一步就是测定底物的干重，可以用炉子烘干样品，然后分析干物质含量，再将样品装瓶或塑料袋带回实验室分析有机干物质含量。

10.2 Digestate 发酵剩余物

1) Analyze the digestate on dry matter and oDM as well (see above).
2) Additionally, analyze the pH, EC and make a titration of the digestate every day.
3) At the end of your sampling campaign, take a 500 ml bottle of substrate and bring it back to your laboratory to analyze organic fatty acids.

1）同样分析发酵剩余物的干物质和有机干物质含量。（看上面方法）
2）另外，每天分析 pH，电导率，做（碱度）滴定试验。
3）全部现场取样工作结束后，装一瓶 500 毫升的底物，带回实验室分析有机脂肪酸。

10.3 Biogas 沼气

Write down the amount of biogas that is produced daily. If a CH4 analyzer is available, analyze the CH4 content of the gas. Additionally, at the end of the sampling campaign, fill some gas into the small glass vials.

纪录每天的沼气产量。如果有甲烷分析仪，分析沼气的甲烷含量。另外，全部现场取样工作结束后，用小玻璃瓶带回一些气体样品。

At the beginning and at the end, take a sample on H_2S.

在开始和结束，取 H_2S 样品。

10.4 Hydraulic parameters 水力参数

You need to determine how much material is pumped into the fermenter. For this purpose, you need to determine the pump rate (see sampling).

你需要监测多少原料被泵入发酵罐。为了达到这个目的，你需要测定泵的效率（看取样部分）

Additionally, you need to crosscheck with the outflow of the digestate (again, see sampling).

另外，你需要反复检查发酵剩余物的流出量（看取样部分）。

11 Sketch of the biogas plant 沼气厂流程草图

We need this figure to understand the overall process. Please include into your sketch the following information/parameters:

我们需要这个流程草图来理解整个流程。请在草图中包含下列信息或参数：

- Fermenters (how many, volume) 发酵罐（数量，体积）
- Feeding tanks (how many, volume) 进料罐（数量，体积）
- Pumps (where are they located, power (kW)) 泵（位置，功率（千瓦））
- Agitators (where are they located, power (kW)) 鼓风机（位置，功率（千瓦））
- Gas storage (volume) 储气罐（体积）
- Storage tank for feeding (volume) 进料储存罐（体积）
- Storage tank for digestate (volume) 发酵废弃物储罐（体积）
- How is the gas used? 沼气用途？
- Is the gas cleaned? 沼气有无净化？

12 H_2S

12.1 Material and Methods 材料与方法

12.1.1 Material 材料

Dräger-tube (No. 8101831), silicon tube (5-10 cm), 100 mL syringe.
Dräger-管(No. 8101831),，硅胶管，100 毫升注射器

12.1.2 Procedure 步骤

Break the two glass ends of the Dräger tube, so that biogas can flow through the tube.
Connect the syringe with the side of the Dräger-tube where you can see the arrow.
Connect to the other side also a small tube that leads to the source of biogas.
Suck 100 mL of biogas through the Dräger tube.
Check the concentration in the Dräger tube (color change)
If the color change is < 40 ppm, then disconnect the syringe from the Dräger tube and press the piston down.
Connect the syringe with the Dräger-tube again.
Suck 100 mL of biogas through the Dräger tube.

Note the concentration and how much mL of biogas you sucked through the Dräger tube. The reading for H_2S refers to 200 mL. If you have used 100 mL, you need to multiply the reading by 2.

Please note: This a specific instruction for a specific DRÄGER tube. Every DRÄGER tube shows a “n=x” on it. This refers to hubs performed by a specific DRÄGER pump. Every hub sucks 200 mL through the DRÄGER tube.

打破 Dräger-管的两端，使沼气可以通过。
将 Dräger-管有箭头的一端与注射器连接。
另一端与沼气来源相连。
吸 100 毫升沼气通过 Dräger 管。
通过 Dräger tube 的颜色变化确定浓度。
如果颜色显示小于 40ppm，取下注射器，推动活塞排空气体。
再次将注射器与 Dräger 管相连。
吸 100 毫升沼气通过 Dräger 管。

注意浓度，以及吸取了多少毫升沼气通过 Dräger 管。该管读数对应的是 200 毫升样品，如果只用了 100 毫升，需要将读数乘以 2。

请注意：对于特殊的 DRÄGER 管需要特殊的仪器。每只 DRÄGER 管上都有“ n=x ”的标记，表现了特定 DRÄGER 泵的中心的性能，每个中心抽取 200 毫升样品通过 DRÄGER 管。

13 Sample biogas into small gas vials 将沼气样品存入气瓶

13.1 Material 材料

Small glass vial, silicon tube, double sided canula, 100 mL syringe with a canula
玻璃瓶，硅胶管，双向针头，100 毫升注射器带针头

13.2 Procedure 步骤

First you have to evacuate the glass vial. Then you fill it with biogas.
首先必须将玻璃瓶的空气排空，然后充满沼气。

Connect the small canula to the syringe.
Put the canula through the septum of the glass vial.
Suck out as much air as possible and then take out the canula.
Fill the syringe with 100 mL biogas.
Inject into the vial 25 mL biogas.
Put the double sided canula into the septum.
Inject the rest of the volume in the syringe into the glass vial.
Remove the syringe
Remove the canula.
Send the sample to gtz Biomass Project.

将注射器与针头连接。
使针头穿透玻璃瓶的塑胶盖。
尽可能抽空空气，然后拔出针头。
用注射器吸取 100 毫升沼气。
向玻璃瓶内注入 25 毫升沼气。
将双向针头插入塑胶盖。
将注射器内剩余沼气注入玻璃瓶。
拔出注射器。
拔出针头。
将样品送至 gtz 生物质能项目组。